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Effect of Radon and Uranium Concentrations with Gender in Colon Cancer: A Comparative Study

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Abstract: **One of the most deadly forms of cancer in the world is colon cancer. Given the numerous genetic, environmental, and occupational factors associated with this disease's incidence, early detection improves treatment outcomes. The study aimed to determine whether there is a relationship between radon and uranium concentrations and the incidence of colon cancer.**

Blood samples for colon cancer patients were collected from the National Hospital for Oncology and Hematology in Najaf and medical clinics as well 60 samples were collected, divided between 35 females and 25 males, for the period from 2021 to 2022. Nuclear trace detector technology was additionally employed to determine the quantity of alpha particles and, consequently, the uranium and radon (^{222}Rn) concentrations, as the radon concentrations in female and male patients were the highest compared to healthy ones, it was also concluded that radon concentrations in general are higher in males compared to females.

Also, the results of calculating uranium (C_u) concentrations were higher in female colon cancer patients compared to healthy people, but in males they were higher in healthy people compared to male colon cancer patients. Also, in general, uranium concentrations in males with colon cancer and healthy people were higher compared to females. The results were also analyzed statistically using the SPSS program version 2023. It is considered a basic preliminary study for such a disease and for the area studied.

Keywords: **uranium, colon cancer, radon, oconology, Iraq.**

1. INTRODUCTION

A collection of aberrant cells that develop out of control by not adhering to the regular laws of cell division is known as cancer. Signals that determine whether a cell should divide, develop into a different type of cell, or die are continuously sent to normal cells. As a result of their increased independence from these cues, cancer cells proliferate and expand out of control. This proliferation has the potential to be lethal if it is allowed to spread. In actuality, metastasis the process by which a tumour spreads is to blame for about 90% of cancer-related fatalities. The second-most common cause of mortality worldwide is cancer [1].

Numerous cancer types are seeing increases in survival rates as a result of advancements in cancer detection, treatment, and prevention. The various types of cells that comprise the body, which are the fundamental building blocks of life, divide and develop under carefully regulated circumstances to keep the body in good condition[2]. Cells die and are replaced with new cells in a controlled manner as they become old or damaged; this process is known as apoptosis [3]. However, this designed procedure occasionally fails. A cell's genetic material (DNA) governs regular cell development and division [4]. Cells do not die if their DNA is damaged or altered, leading to mutations; instead, cells do not die and continue to divide even when the body does not need them, hese excess cells create a mass of tissue known as a tumor [5] .

Benign and malignant tumours are the two categories into which tumours are divided, malignant tumours can spread to other parts of the body and are carcinogenic, whereas benign tumours are not and do not spread to other parts of the body[6]. The cells that make up human tissues and organs proliferate and develop continuously until they stop in a controlled way[7].

Colon Cancer

Although it has a complex etiology, colorectal cancer is one of the most curable and preventable tumours if discovered early.The adenomatous or serrated polyps (adenoma), which typically develop in the proximal or distal colon, are the distinguishing feature of colorectal cancer [8] . In addition to adenomas, several aberrant cryptfociminuscule mucosal abnormalities implicated in early carcinogenesis are present in patients with colorectal cancer.Genetic variables include polymorphisms in nucleic acid-binding proteins and mutations in the KRAS, BRAF, and PI3K genes[9]. Colon cancer is one type of cancer that originates in the colon, which is the big intestine, The colon marks the end of the digestive system. Although it can affect anyone at any age, colon cancer mostly affects those who are older [10]. Usually, it begins as benign, noncancerous cell groupings called polyps that grow inside the colon. Colon cancer may eventually arise from a few of these polyps. Small polyps could not produce a lot of symptoms[11]. As a result, doctors recommend routine screenings to identify and remove polyps before they become cancerous in order to help prevent colon cancer. If colon cancer develops, a variety of treatments are available to help manage it, such as radiation therapy, surgery, and drug treatments like immunotherapy, chemotherapy, and targeted therapy[12]. Many people have no symptoms at all when colon cancer first appears. The initial manifestation of symptoms may vary depending on the location and size of the large intestine cancer [13].

Al-Rubyie (2004) used a CR-39 track detector to measure the amount of uranium in blood samples collected from patients from various Iraqi governorates and a control group. The results revealed that the maximum concentration was 1.89 ppb and the lowest concentration was 0.33 ppb[14]. By comparing the levels of concentrations in the blood serum of colon cancer patients to those of healthy individuals, the study sought to determine if radon gas concentration and uranium concentration were associated with the incidence of diseases like colon cancer in both sexes. The findings could aid in the early diagnosis of such a disease.

Radon

Radon is an odourless and colourless gas that is produced when radioactive radium, which is uranium's decay product and is present in the Earth's crust, breaks down. The byproducts of radiation decay ionize genetic material, leading to mutations that can occasionally develop into cancer. For every 100 Bq/m^3 increase in radon concentration, the risk rises by 8–16%, local variations in radon gas concentrations are caused by the rocks and soil beneath them [15]. The heaviest noble gas in nature, radon is a naturally occurring gas that is colourless, odourless, radioactive, and tasteless. Radon has a half-life of 3.82 days. Because of its extended half-life in comparison to other isotopes and the health risks associated with exposure to its radioactive daughters, it is the most significant isotope. More than 54 percent of the natural radiation that people have been exposed to comes from radon[16] . Due to the serious health risks associated with radon, radon monitoring is done in many different settings worldwide. As uranium decays, radon is produced naturally.Three naturally occurring isotopes of radon, 222Rn, 220Rn, and 219Rn, are produced by three distinct radioactive decay pathways[17].

2. METHODOLOGY

Solid state nuclear track detector (SSNTDs)

The primary source of radiation exposure for humans is natural radioactivity. It is acknowledged that radon (222Rn) and its rapidly decaying byproducts are the primary sources of the population's committed effective dose from natural sources.There are two types of procedures for measuring and collecting 222Rn in air: active methods, which need electricity to gather a sample, and passive methods, which don't require any power at all. Active techniques are typically employed for shorter radon measurement times[18]. The alpha particles that are released are measured to assess the concentration of radon, which damages the detector surface. The CR-39 is currently the most advanced track detector for ambient radon monitoring due to its high degree of optical clarity, good ionization sensitivity, and stability under a variety of environmental circumstances[19]. To find the radon concentration, one has to know the track density (track per cm2 in the detector surface), the exposure time, and the calibration factor that converts the track density to radon concentration[20].

The objective of this work is to find the calibration factor for passive radon concentration measurements using CR-39 solid state nuclear track detectors. Blood samples were also examined using SSNTDs.

A unique type of method NTDs CR-39, this detector is very beneficial because of its high degree of visual clarity, stability against different environmental variables, and good sensitivity. The primary mode of exposure to invasive radionuclides, such as radon, is inhalation. Due to the short half-life of radon, biological samples including serum, urine, and blood will be used for the measurement. To measure radon concentrations, one must ascertain the diffusion constant (K) for the alpha particle system and the diffusion constant varying between systems based on the geometric dimensions of the diffusion chamber (radiation) [21], where K calculated by equ 1.

$$K = \frac{1}{4} r.\left(2cos\theta c - \frac{r}{Ra}\right) \qquad 1$$

where r = (1.75 cm) is the tube's radius and $\boldsymbol{\theta c}$= 35◦ is the critical angle for CR 39 detectors. The typical alpha particle range in air to 222Rn is Ra = (4.15cm). It is able to compute the relationship's track density ($Tr.cm^{-2}$):

$$\rho = \frac{Numbers\ of\ tracks}{Area\ of\ field\ view}$$

$$\rho = K.Ca.T \qquad 2$$

where Ca is the concentration of radon gas in space, and ρ is the alpha track density caused by radon ($Track.\ cm^{-2}$). ($Bq.m^{-3}$) and determine the average track density ($Tr.cm^{-1}.h^{-1}$) for the relationship:

$$D = \frac{\rho}{T} = k.Ca \qquad 3$$

We can find radon activity (radon concentration) by using the relations[22].

$$C_s = \lambda_{Rn} C_a \frac{ht}{L} \qquad 4$$

where λ_{Rn} is the constant of radon decay and Cs is the radon concentration in the sample, h = (5.5 cm) , t = (time of exposure) , L(length of sample) = (0.5 cm) , It is possible to determine the radioactivity of radon using the following relationship:

$$A_{Rn} = C_s V \qquad 5$$

Where V the size of the air space is calculated from the relationship, $V = \pi r^2 h$

Activity of radon concentration Calculation of [23]

$$A_{Rn} = \lambda_{Rn} N_{Rn} \qquad 6$$

Through their The number of uranium atoms is found Nu, and the weight of uranium in the dry sample is estimated using the law of radiation equilibrium, which is represented by the formula ($\lambda uNu = \lambda RnNRn$) [24].

$$W_u = \frac{NuAu}{Na} \qquad 7$$

In this case, λu represents the fixed uranium dissolving amount of $4.9\times 10^{-18}\ s^{-1}$. The symbols Au and Na denote the mass number of uranium (^{238}U) and Avogadro 6.02×10^{23} atoms, respectively. Uranium concertation is represented by equ. 8:

$$C_u = \frac{W_u}{M_D} \qquad 8$$

CR-39 NTDs

Columbia Resin, a C12H18O7 polymer with a density of 1.31 g cm^{-3}, is used in the CR-39 plastic track detector [25]. The ideal detector employed in this investigation is manufactured by Intercast Europe SRL (43100 Parma, Italy), as Figure 1 illustrates. The NTD's square component measures 2.5 x 2.5 x 0.1 cm^3. In the prior trial, CR-39NTD efficiency was 79.5%. CR-39 has a sensitivity that allows it to physically detect low energy alphas. The latter provides a precise estimation of the real concentration of radon .

Study Site

The study area is located in National Hospital for Oncology and Hematology (NHOH) in Najaf, Iraq to collect samples of colon cancer patients aged 19 to 70year . Control samples were collected from the main blood bank in the central part of Najaf, Iraq.

Sample Preparation

These samples were weighed before analysis, each of which was 1 gm, put in PVC containers. The sample was prepared after the sample was brought in ambient temperature. The number of female samples was 68 samples, divided into 35 samples for healthy men and 33 samples for colon cancer patients, while the number of male samples was 51 samples, divided between 25 samples for healthy men and 26 samples for colon cancer patients. The size of the detectors was 2.5cm x 2.5cm x 0.1cm. After that, the radon dosimeters were placed inside the PVC tube 6.5 cm high and 3.5 cm diameter. Suspected detectors inside the PVC tube. Following that, the blood tubes were kept in the hospital refrigerator for ninety days fitted with detectors. Ensuring that the samples attained a condition commensurate with the radionuclides they contained was the aim of the storage. The samples were sealed and kept at 4 °C without being shaken.

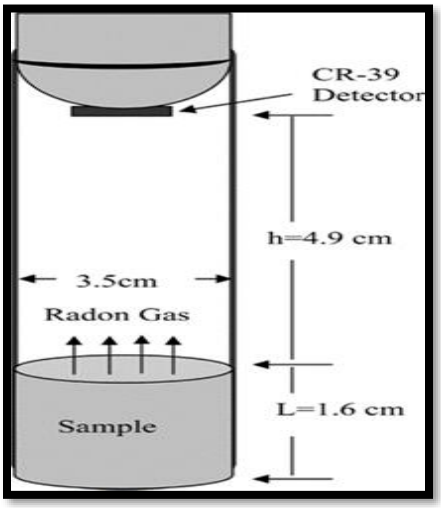

Fig 1: PVC tube containing serum and detector CR-39

Etching process and scanning process

The current investigation used an etching CR-39 detector, which was created by TASL and produced by TASTRAK firm (Ltd., UK: TASTRACK). These detectors have many characteristics, including size (2.5 cm x 2.5 cm), density (1.32 g/cm^3), thickness (1 mm), and unique codes and numbers that correspond to the TASL picture system for each detector. Following the completion of the secular equilibrium period, samples of decorative materials were placed in the bottom of the tube, and radon concentrations were determined. Next, a CR-39 detector was installed at the bottom of the tube cover using adhesive tape, and the tube was stored for 90 days (the exposure time) to guarantee that the radionuclides in the samples reached equilibrium. The covers of the containers were sealed with a layer of adhesive tape to stop radon gas from escaping. The current study employed a long-term radiation strategy, the detectors are taken out of the containers and the chemical etching process starts when the irradiation period is over. Over the course of the following ninety days, CR-39 detectors were submerged for one hour in a 6.25 N NaOH solution at 98˚C.

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The figure 2 shows the (Alpha system Tasl) system with all its parts, in addition to the computer on which the program's software was installed and through which the nuclear trace detectors were scanned, where many images containing many traces appeared C shows one of these images.

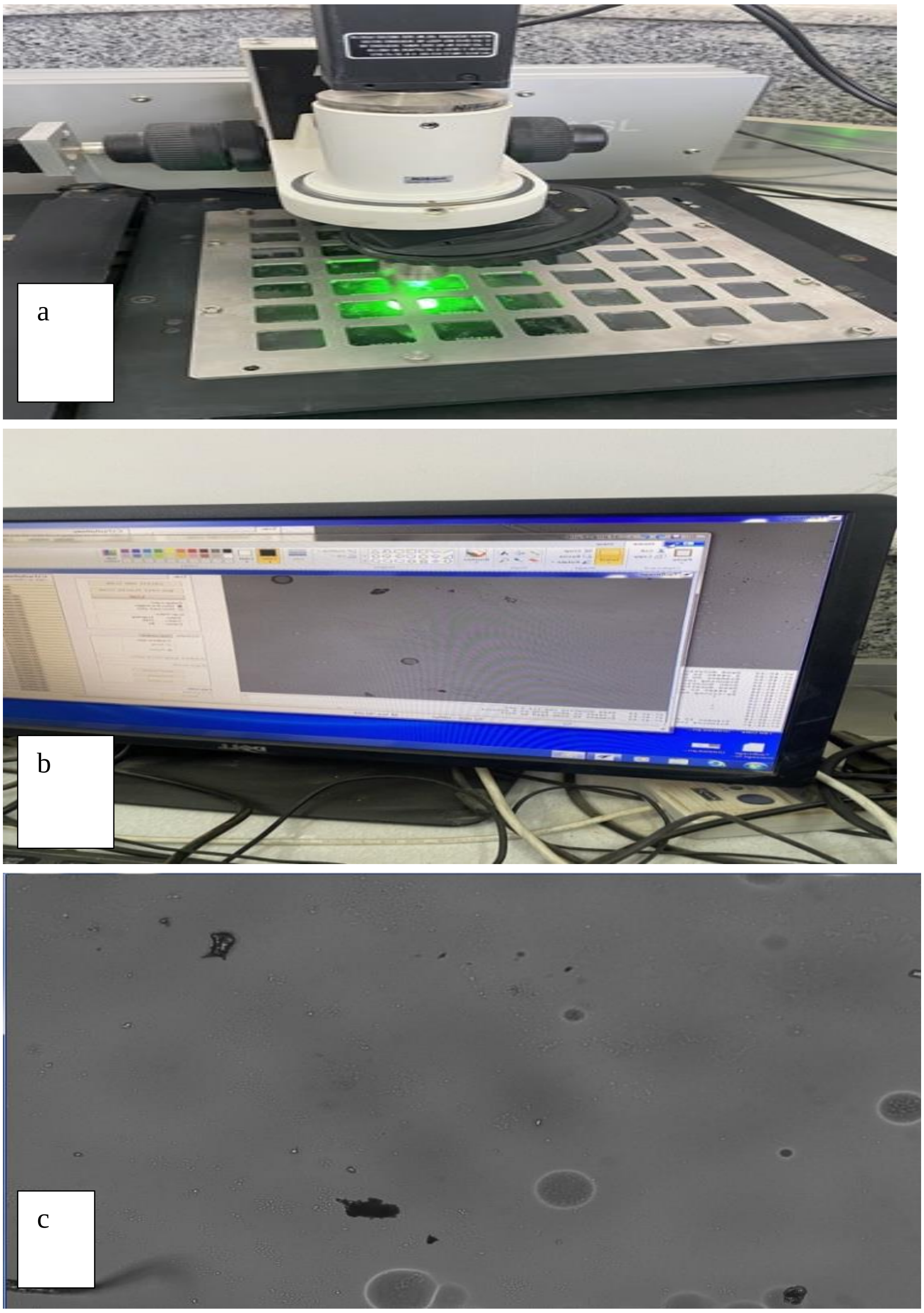

Figure 2 : Alpha system Tasl as in (a and b) also c representated image of serum sample on SSNTD detector CR-39.

3.   RESULTS AND DISCUSSIONS

The best way to track the alpha particles released by radon melting in the human body is by blood testing. It's a useful method. Solid state nuclear track detectors (SSNTDs) aid in the natural assessment of blood sample alpha values Equations 2 allowed us to calculate the uranium concentration (ppb) and the concentration of radon in space (Ca(Bq/m^3)) for both the normal case and the cancer colon for the two genders listed in Tables 2 and 3 and Figures 3 and 4 below.

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Table 1: A descriptive table of the cases from which blood samples were taken.

Characteristics	Colon Cancer		Control	
Sex	N	%	N	%
Female	35	58.33	33	55.93
Male	25	41.66	26	44.06
Total	100		100	
Age	19 – 70 year			
Chemotherapy	yes		yes	

Table 2: Comparison between radon concentrations for colon cancer and healthy controls for both gender by indepent test.

gender	Groups	N	Mean	Std. Deviation	P- Value
female	H	33	17.018	1.207	0.005*
	CG	35	22.622	1.445	
male	H	26	93.979	17.989	0.573
	CG	25	43.830	3.961	

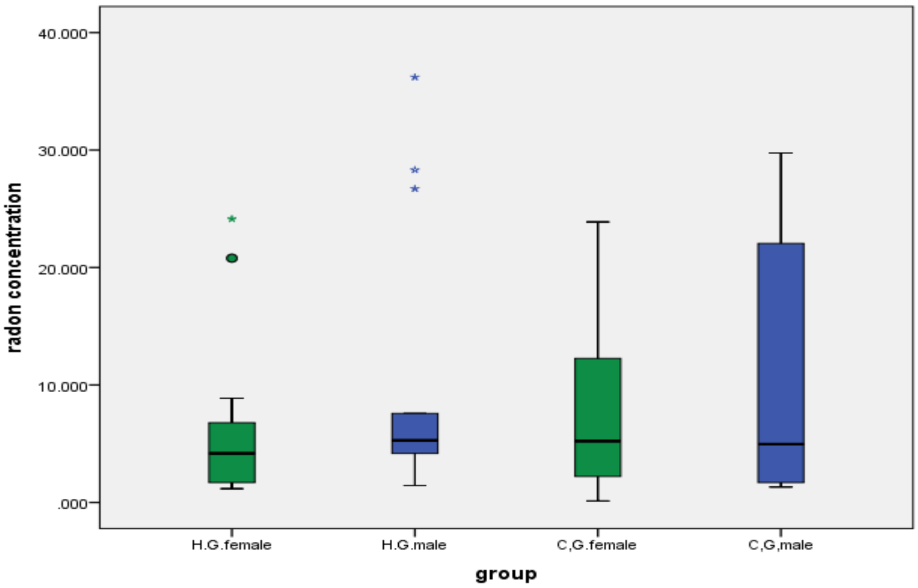

Figure 3: Comparison of radon concentrations for both gender using the ANOVA test.

Table 3: Comparison between uranuimconcentrations for colon cancer and healthy controls for both gender by indepent test.

Gender	Groups	N	Mean	Std. Deviation	P- Value
female	H	33	6.127	0.654	0.007*
	CG	35	9.507	0.666	
male	H	26	10.489	1.428	0.482
	CG	25	11.137	1.379	

We note that from Table 2, the statistical comparison was made using the statistical program, edition 23, using the independent samples test between sample of blood of healthy females, 33 cases, and those with colon cancer, 35 cases. There were individual differences between the means, so the p - value was much less than 0.05, It shows that there is a statistically significant difference between the two groups (health and female colon cancer).The blood samples studied also showed that radon concentrations were higher in women with colon cancer compared to healthy female .

However, it was for males, which included 26 blood samples from healthy males and 25 samples from the blood of male colon cancer patients. There was no statistical significance between the two groups (healthy males and colon cancer patients), as the p - value was 0.48 in favor of an increase in radon concentrations in the blood of those infected.

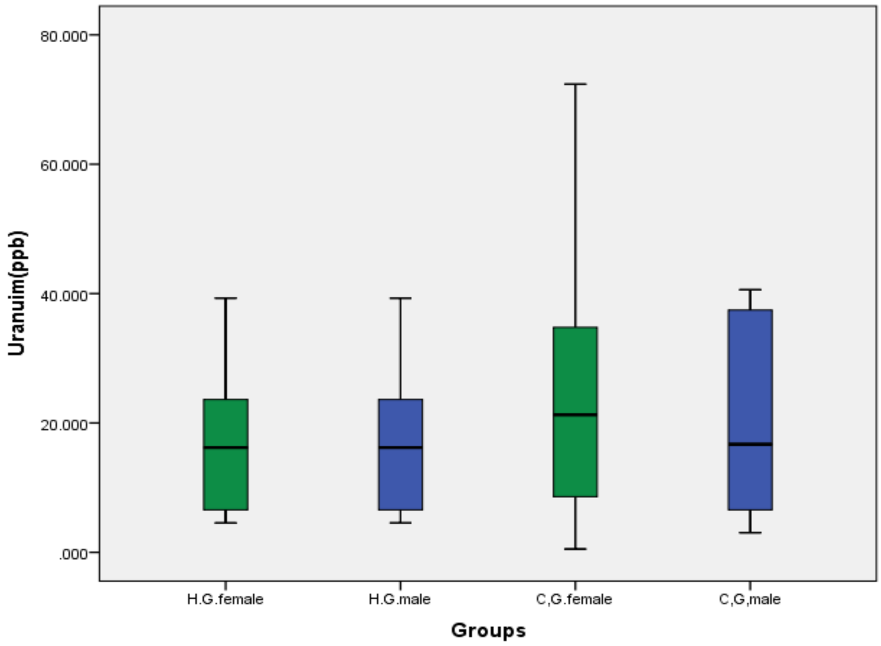

Figure 4: Comparison of uranuim concentrations for both gender using the ANOVA test.

We note that from Table 3, sample of blood of healthy females, 33 cases, and those with colon cancer, 35 cases. Since the means varied across the individuals, the p-value was significantly less than 0.05, indicating that there was a statistically significant difference between the two groups (health and colon cancer) in the female group ($p = 0.005$). The blood samples studied also showed that uranuim concentrations were higher in women with colon cancer compared to healthy female .

However, it was for males, which included 26 blood samples from healthy males and 25 samples from the blood of male colon cancer patients. There was no statistical significance between the two groups (healthy males and colon cancer patients), as the p- value was 0.573 in favor of an increase in uranuim concentrations in the blood of those health, it was also the highest, this comparison is more clear in Figure 4.

An anova test was also conducted between the studied groups for radon and uranium concentrations where was no statistical significance when conducting the ANOVA test among the four studied groups of females for the values of radon concentrations. The same is the case for uranium concentration, where the probability value (p-value) was greater than 0.005.

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Approval from an Ethical Perspective

The study protocol was approved by the local ethics committee.

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